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CENTENNIALS AND SESQUICENTENNIALS DURING 1951 WITH INTEREST FOR CHEMISTS AND PHYSICISTS

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Under modern conditions maintenance of historical perspective becomes increasingly difficult. This appears to be especially true in science where specialization has now been carried so far that workers in a single field can often scarcely communicate with each other except through the mediation of their as yet incompletely specialized students. Any device which will facilitate a synthesis of disciplines, promote breadth of view, and develop even an elementary degree of perspective may, therefore, be welcomed by those who still believe that these qualities have value. One such simple tool which has already proved its worth is scientific biography.

The present paper continues one aspect of a more general plan first conceived some years ago[1] and more recently specifically implemented by articles[2] presenting surveys of important anniversaries of notable scientific workers occurring during the corresponding years. The same simple notational methods previously employed are continued, but in order to facilitate easy reference the individual subjects of this paper have been arranged in alphabetical sequence. Since the chronological occurrence of their anniversaries is also represented in tabular form, the combination of these procedures retains the advantages of both. Finally, in view of the substantial collection of these sketches now available, an index including all entries from these three similar papers has been supplied.

In view of inevitable limitations of time and space, the subjects of these biographical digests have been selected from a host. Among those for whom detailed treatment cannot here be given may be mentioned Jacques Arsène D'Arsonval (1851–1940) of the D'Arsonval galvanometer; Lajos Ilosvay (1851–1936), chemist; Johannes Kahlbaum (1851–1909) of the famous chemical supply house; Apollon A. Kurbatow (1851–1903), Russian chemist; William Francois Oechsner de Coninck (1851–1917), French chemist; Joseph Antoine Ferdinand Plateau (1801–1883), the blind Belgian physicist; together with Anders

[1] Huntress, J. Chem. Education *14*, 328–344 (1937).
[2] Huntress, Proc. Am. Acad. Arts Sci. *77*, 33–54 (1949); *78*, 1–35 (1950).

Celsius (1701–1747), Swedish astronomer and establisher (1742) of the Celsius (centigrade) thermometric scale.

Of the twenty-five subjects comprising this treatment for 1951, twenty-two represent 100-year anniversaries while three are sesquicentenary memorials.

MEMORIAL DATES DURING 1951

Jan. 8.	Centenary of birth of T. WEYL
Jan. 14.	Centenary of birth of L. CLAISEN
Jan. 19.	Centenary of birth of J. F. EYKMAN
Feb. 18.	Centenary of death of K. G. J. JACOBI
Mar. 9.	Centenary of death of H. C. OERSTED
Mar. 10.	Centenary of birth of W. MCMURTRIE
Apr. 6.	Sesquicentenary of birth of W. H. MILLER
Apr. 22.	Centenary of birth of W. KOENIGS
May 5.	Centenary of birth of W. M. HEMPEL
May 20.	Centenary of birth of E. BERLINER
June 8.	Centenary of birth of D. E. NOELTING
June 11.	Centenary of birth of E. HEPP
June 12.	Centenary of birth of SIR O. J. LODGE
June 19.	Centenary of birth of S. P. THOMPSON
July 10.	Centenary of death of L. J. M. DAGUERRE
July 16.	Sesquicentenary of birth of J. PLÜCKER
Sept. 12.	Centenary of birth of SIR A. SCHUSTER
Sept. 21.	Centenary of birth of M. H. JACOBI
Oct. 9.	Sesquicentenary of birth of A. A. DE LA RIVE
Oct. 27.	Centenary of birth of V. C. VAUGHAN
Nov. 7.	Centenary of birth of S. GABRIEL
Nov. 10.	Centenary of birth of W. C. BRØGGER
Nov. 16.	Centenary of birth of O. BILLETER
Dec. 15.	Centenary of birth of G. SCHULTZ
Dec. 25.	Centenary of birth of H. FRASCH

BERLINER, EMILE

Born May 20, 1851, at Hanover, Germany; died August 3, 1929, at Washington, D. C., U. S. A., at age 78.

This German-born American inventor, whose accomplishments still facilitate and enrich the daily life of almost every citizen, seems to be little known to present-day students.

Berliner's only formal education was obtained prior to the age of 14 at the Samson School of Wolfenbüttel near his native city. His

father was a talented Talmudic scholar who, recognizing the influence of growing Prussian autocracy and militarism, allowed the 19-year-old son to emigrate (1870) to the United States, where five years later he took out first papers for citizenship. For three years the boy found employment in the Washington haberdashery of a family friend, then spent a year as salesman or "drummer," travelling between St. Paul and St. Louis for a Milwaukee clothing firm, subsequently working briefly in New York City in the analytical laboratory of Dr. Constantine Fahlberg. In this last post he spent much of his leisure at the library of Cooper Institute, developing a constantly growing interest in the study of electricity and magnetism. An accidental meeting with his initial Washington employer resulted (1876) in his return to his original work in that city which, except for one seven-year period (1878–83) in Boston, became his permanent American residence.

Much intrigued by Alexander Graham Bell's invention (1875) of the telephone, Berliner devoted his spare time to further electrical experimentation, using as his laboratory his third floor room in a house at 812 Sixth St., N.W., closely adjacent to his place of employment. Here at the age of 25 he invented (April 8, 1877) the loose contact telephone transmitter or microphone which, by utilizing a different principle, overcame the serious inadequacies of the earlier Bell instrument and is still the basis of all modern telephone transmitters and radio microphones. Under the patent system then in force an inventor was privileged to file a caveat amounting to a declaration of intent to present subsequently a regular application. Berliner himself personally prepared and on April 14, 1877, filed such a brevet, which because of its concise accuracy and completeness is still regarded as one of the most remarkable documents in Patent Office history. The corresponding formal application, although deposited on June 4, 1877, encountered "interferences" and fourteen years elapsed before the patent was eventually issued as U. S. 463,569 on November 17, 1891. Meantime within a month of the invention of the microphone, Berliner discovered that its transmitting power could be greatly enhanced by combining with it suitable induction coils, this major invention quickly being protected by patent No. 199,141, issued on January 15, 1878. As an immediate consequence of these two inventions Berliner became associated with the Bell Telephone Company and for the next seven years (1878–83) was employed at its Boston headquarters. During this period he married and for several years lived in Cambridge near Harvard Square.

Fortified by an ample income and already at 32 a recognized captain of industry, Berliner again took up residence in Washington and resumed independent experimentation. The first fruit of this renewed

interest was the invention (1887) of what he himself designated as the "gramophone". This method for the recording and reproduction of sound is not to be confused with the earlier (1877) Edison phonograph or its variants. Whereas the Edison method employed recordings in which the sound waves were vertically indented or engraved on cylinders, the Berliner gramophone recorded the sound track laterally on flat discs and was protected by a patent issued as U. S. 372,786 on November 8, 1887. He implemented this advance by further inventions comprising a suitable disc composition and a method of photoengraving a master matrix from which any desired number of duplicates could be pressed. This group of fundamental inventions was promptly purchased by the Victor Talking Machine Company and formed the foundation from which present-day forms of sound recording have developed. On the 25th anniversary (1913) of his first exhibition of the gramophone on its premises, the Franklin Institute of Philadelphia awarded to Berliner its Elliott Cresson Medal (at that time its highest award) at ceremonies in which acknowledgments of achievement in other fields were presented to Charles P. Steinmetz, Lord Rayleigh, and Emil Fischer. [For Berliner's own account on this occasion of "The Development of the Talking Machine," see J. Franklin Inst. *176*, 189–200 (1913).] Another quarter century later (1929) Berliner's career was crowned by the Franklin Institute's Franklin Medal (established in 1914) at exercises which preceded his death by only a few months.

Berliner's practical and technical virtuosity extended also to other fields. He was the first (1909) to make and use in aeronautical experiments a light-weight revolving cylinder internal combustion engine. Later (1919) his son, Henry A. Berliner, designed and built under his father's direction a helicopter able to sustain itself. At the age of 74, the senior Berliner interested himself in architectural acoustics and patented (U. S. 1,573,475, Feb. 16, 1926; 1,628,351, May 10, 1927; 1,740,147 and 1,740,148, Dec. 17, 1929) several acoustic materials and methods representing pioneer work in this now important field.

Aroused in 1900 by the severe illness of an infant daughter, Berliner began a protracted campaign of public health education particularly directed toward the dangers of raw milk. One result of these efforts was the first (1907) scientific conference on milk ever held in the United States [for its proceedings and reports see U. S. Dept. of Agriculture, Circular 114], the standards set by which have since been widely incorporated in state and municipal regulations. In memory of his mother he also established (1911) the Sarah Berliner Research Fellowship administered by the Association of University Women to make

available to qualified women candidates opportunities for post-doctoral research experience. A biographical volume by Frederic William Wile (including in an appendix the complete text of the famous caveat describing the microphone), warmly commended to the attention of technical students, was published during its subject's 75th year by the Bobbs Merrill Company of Indianapolis.

B J. Franklin Inst. *176*, 101–102, 111–112 (1913): P_1B Natl. Cycl. Am. Biog. *21*, 6–7 (1931): B Dict. Am. Biog. *31*, (1st Suppl. Vol.) 75–76 (1944).

BILLETER, OTTO

Born Nov. 16, 1851, at Feuerthalen, near Schaffhouse, Switzerland; died Dec. 3, 1927, at Neuchatel, Switzerland, age 76.

This Swiss organic chemist, the next to the youngest of eight children, was the son of a father whose small plant for the distillation of wood and manufacture of metal salts intended for the weighting of silk doubtless interested him in chemistry.

The son's early education at Schaffhouse was followed by four years (1868–72) in the chemical section of the Federal Polytechnic Institute at Zurich where his professors included J. Wislicenus (1835–1902) and Emil Kopp (1817–1875). After a period in the Oehler dyestuff plant at Offenbach on the Mainz, he returned to Zurich where at the University, Billeter served as assistant to Wilhelm Weith (1844–1881) and obtained (1875) his doctorate with a dissertation [Ber. *8*, 462–466 (1875)] on aromatic thiocyanates. Upon the recommendation of Victor Meyer (1848–1897), Billeter succeeded Frederic Sacc (1819– ?) as Professor of Chemistry at the Academy of Neuchatel where his entire subsequent life of 52 years (1875–1927) was spent. During this period he served three times (1881–2, 1889–91, 1895–7) as Rector of the Academy and later (1909) played an important role in its transformation to the University of Neuchatel. He retired (1925) with the title of honorary professor.

During his long life at Neuchatel he took a prominent part in civic affairs and was an active member and thrice president (1891–2, 1893–5, 1899–1901) of the Société Neuchateloise des Sciences in whose Bulletin he published much of his research. He was also the principal agent in the founding of the Swiss Chemical Society, served (1901–3) under Alfred Werner (1866–1919) as its first vice-president, and immediately thereafter (1903–5) as its second president. His subsequent activities in this group included membership in the special

commission as a result of whose recommendations the Helvetica Chimica Acta was established in 1918.

Until the Neuchatel Academy became a university it lacked authority to confer doctorates; consequently during Billeter's first 34 years of his professional career he was deprived of the benefits of numerous collaborators. Most of his published work was concerned with the structural chemistry of organic compounds containing both sulfur and nitrogen such as the thiocyanates, isothiocyanates, thioureas and related classes. Through his studies of the behavior of thiophosgene with secondary amines, he was led to the discovery [Ber. *20*, 1629–1632 (1887); *21*, 102–110 (1888)] of disubstituted thiocarbamyl chlorides and subsequently pursued extensively the chemistry of this class, particularly with reference to polysubstituted dithiobiurets. With his son, Otto Billeter, Jr., he was the first (1901) to prepare acyl isocyanates such as acetyl isocyanate [Ber. *36*, 3213–3218 (1903)], benzoyl isocyanate [Ber. *36*, 3218–3221 (1903)], and benzenesulfonyl isocyanate [Ber. *37*, 690–696 (1904)]. These were obtained by interaction of the corresponding acyl chlorides with silver cyanate, and proved reactive reagents able to serve in the characterization of hydroxyl or amino groups.

During the last five years of his active career, Billeter turned from organic chemistry to an important study of the methods for determination of arsenic, the necessity for which had been brought to his attention by contacts with a local toxicological investigation. This work led to the development of new methods [Helv. Chim. Acta *1*, 475–498 (1918); *6*, 258–259, 771–779, 780–784 (1923)] able to detect as little as 0.01 mmg. of this element.

P_1B Helv. Chim. Acta *11*, 700–710 (1928) (incl. bibliog.).

Brøgger, Waldemar Christopher

Born Nov. 10, 1851, at Christiania (now Oslo), Norway; died Feb. 17, 1940, at Oslo, Norway, age 89.

Despite the fact that 90% of his long life was spent in his native country and all but a few years of his professional career at his own alma mater, this peerless Norwegian scientist was at the time of his death regarded as the most distinguished geologist in Scandinavia and perhaps the entire world.

After receiving his education in Oslo at the Cathedral School and his elementary geological training at the University under T. Kjerulf (1825–1888), Brøgger was appointed (1875) as assistant on the geological survey of Norway and the following year (1876) also curator

of the university's mineral collections. At the age of 30 he accepted a call to the chair of geology and mineralogy of the Stockholm Technical High School (Högskola) where through nine years (1881–90) he held one of the two professorships which initiated the teaching program of this distinguished institution. Upon the death of his former mentor, Brøgger returned to succeed Kjerulf at Oslo University where he spent the subsequent 26 years (1890–1916) until his retirement at age 65. As professor emeritus he continued active research and creative writing for another two decades. During his entire Oslo career Brøgger occupied a unique position of leadership not only as the central personality of the Norwegian Academy of Science, but also as a public figure whose service included terms as a member (1906–09) of the Norwegian Parliament (Storthing) and as first (1907–11) Rector of the University.

Brøgger's many and voluminous published works [for a complete bibliography see Norsk Geol. Tids. *20*, 199–249 (1941)] covered an almost unprecedented scope including the fields of mineralogy, petrology, paleontology, stratigraphy, glaciology, mapping, tectonics, prehistory, and archeology. Indeed his first paper (1873), reporting on the distribution of molluscs in Oslo Fjord, comprised what must have been one of the earliest detailed studies in ecology. The main theme of his interest at Stockholm was his mineralogical study of the alkali-syenite pegmatites of Friedricksvärn and the Langesunds Fjord, culminating in his epochal memoir [Z. Krystallog. *16*, Allgemeiner Theil 1–235; Specieller Theil 1–663 (1890)] on "The Minerals of the Pegmatite Dykes of the South Norwegian Augite and Nepheline Syenites." In the analysis of many of the new and complex minerals described in this work, Brøgger was notably assisted by the distinguished chemists Per T. Cleve (1840–1905) and Christian W. Blomstrand (1826–1897). Brøgger later (1900–01) produced our most important work on the quaternary geology of Norway, in which far-reaching conclusions on the geological and climatic history of the Oslo Fjord district were presented. In 1905 he gave the first treatment of the relation of the Stone Age Settlements to the varying heights of the shore lines of the same region, an achievement of fundamental importance to Norwegian archeology.

Brøgger's genius was recognized both at home and abroad. He was elected a Foreign Member of the Royal Society of London (1902) and Foreign Associate of the U. S. National Academy of Sciences (1903). He was a correspondent of the Institute of France, held honorary degrees from many universities including Cambridge, Oxford, Glasgow, Heidelberg, and Stockholm, and received both the Murchison (1891) and Wollaston (1911) Medals of the Geological Society of London.

P_1B Obit. Notices Fellows Roy. Soc. (London) *3*, 503–517 (1941): P_3B Am. Mineral. *26*, 167–173 (1941): P_3B Mineralog. Mag. *28*, 186–187 (1947): P_1B Proc. Geol. Soc. Am. *1940*, 167–170: B Quart. J. Geol. Soc. London *97*, lxxvi-lxxvii (1942 for 1941): B J. Geol. *48*, 444–445 (1940): B Nature *145*, 652 (1940): B Proc. Roy. Soc. (London) *A-177*, 7–8 (1940): B Naturwissenschaften *28*, 617–619 (1940): 2 P_2B Geol. Rundschau *31*, 297–299, 300–301 (1940): P_3B Zentr. Mineral. Geol. *1941*, A, 25–31: B Compt. rend. *210*, 321–323 (1940): P_1B Norske Videnskaps-Akad, (Oslo) Arbok *1941* (for 1940), 29–53, 53–60 (in Norwegian): P_1B Naturen (Bergen) *64*, 97–99 (1940) (in Norwegian): B Tids. Kjemi Bergvesen *20*, 21–22 (1940) (in Norwegian): 2 P_3B Geol. Fören. Förh. Stockholm *62*, 109–111, 112–120 (1940) (in Swedish): P_3B Medd. Danske Geol. For. *9*, 646–648 (1940) (in Danish).

Claisen, Ludwig

Born Jan. 14, 1851, in Cologne, Germany; died Jan. 5, 1930, at Godesberg-am-Rhein, near Bonn, Germany, age 79.

This illustrious German organic chemist attended, up to age 18, the Catholic gymnasium of the Apostles Church at Cologne. His subsequent university career was divided between Bonn and Göttingen. Upon entering (1869) the former, he was the pupil in chemistry of Kekulé (1829–1896), in physics of Clausius (1822–1888), in analysis of Engelbach (1823–1872), in crystallography of Rath (1830–1888), in mineralogy of Nöggerath (1788–1877), and in botany of Hanstein (1822–1880). During the interruption of this program caused by the Franco-Prussian War, Claisen served in the ambulance corps. Apparently temperamentally incompatible with Engelbach, Claisen spent the next academic year at Göttingen, studying mathematics with Stern (1807–1894), theoretical chemistry with Hübner (1837–1884), technical organic chemistry with Tollens (1841–1918) and working in the laboratory of Wöhler (1800–1882). When upon the death of Engelbach, Zincke (1843–1928) succeeded him as Kekulé's assistant, Claisen returned to Bonn and attained (1874) his doctorate with a dissertation on the relationships between acetone, mesityl oxide and phorone.

The subsequent 51-year period of his active professional career may be divided into two parts. In the first between the ages of 24 and 56 he was located in no less than seven different universities. Following his doctorate he stayed on for seven years (1875–82) at Bonn as the successor of Otto Wallach (1847–1931). The next three years (1882–5) Claisen spent at Owens College of Victoria University in Manchester, England, as an associate of Roscoe (1833–1915) and of Schorlemmer (1834–1892). He next joined his friend Wilhelm Königs (1851–1906)

at Baeyer's laboratory in Munich, where for four years (1886–90) he was associated with a distinguished group which included Bamberger (1857–1932), Curtius (1857–1928), von Pechmann (1850–1902), and W. H. Perkin, Jr. (1860–1929). At the age of 39 Claisen was called to the Technische Hochschule at Aachen where as associate professor he remained seven years (1890–1897), leaving for a similar post (1897–1904) at the University of Kiel. This he relinquished to accept (1904–1907) an appointment in the laboratory of Emil Fischer (1852–1919) at Berlin. In the second part of his career he established at Godesberg, near Bonn, a private laboratory in which with the help of numerous assistants he actively prosecuted organic research for almost two decades (1907–1926).

It is manifestly impossible even to mention the topics with which his numerous contributions to organic chemistry were concerned. By modern students his name is perhaps most frequently associated with the Claisen condensation, the Claisen flask for distillation under reduced pressure, his work on tautomerism, and his epochal work upon the thermal rearrangement of allyl aryl ethers to the corresponding phenols. He was undoubtedly one of the great organic chemists of his period but his Kiel colleague Heinrich Biltz has recorded that Claisen's scientific strength had one limitation, viz., that he was primarily concerned with organic synthesis.

P$_1$B Ber. *69-A*, 97–170 (1936) (incl. bibliog.): B Giorn. chim. ind. appl. *12*, 106 (1930).

DAGUERRE, LOUIS JACQUES MANDÉ

Born Nov. 18, 1787, at Cormeilles-en-Parisis, France; died July 10, 1851, at Petit-Bry-sur-Marne, Paris, France, age 64.

Although initially only an artist and scene painter, Daguerre's name is most widely known in the scientific world because of his part in the development of photography through the medium of daguerreotypes. The long and involved history of this discovery (which can merely be summarized here) is perhaps most conveniently set forth in Eder's "History of Photography" as translated by Edward Epstean, Columbia University Press, New York, 1945.

Daguerre, a pupil of the well-known scene painter, Degotti, showed exceptional ingenuity in the handling of scenic and lighting effects for various Parisian theaters. About 1822 he conceived the idea of developing the panorama into a "diorama" in which paintings were caused to undergo various changes in appearance by means of variable

lighting. With another painter, Bouton, he opened his Diorama on July 11, 1822, in a spacious showroom at 4 Rue de Sanson in Paris. For 17 years until it was destroyed by fire in 1839 this display achieved great popularity and comprised one of the main attractions of the city.

Along with his artistic and commercial labors, however, Daguerre applied himself diligently to scientific studies of light and its behavior. Through a mutually friendly optical dealer, Daguerre was brought into contact with Joseph Nicephoré Niépce (1765–1833) who had simultaneously but quite independently been making experiments which led him (1822) to the first successful photographic process. On Dec. 14, 1829, the two men signed a contract establishing the Niépce-Daguerre Company for the perfection of Niépce's photographic process. Within four years, however, the original senior partner died, and his place was taken by his son Isidore, the company then becoming Daguerre and I. Niépce. Meantime, Daguerre discovered (1831) the photosensitivity of silver iodide and was the first to employ iodized silvered plates as the light sensitive coating by which photographic images could be obtained. Still later (1837) Daguerre discovered that the latent image on these plates could be developed by exposure to mercury vapor, and negotiated with I. Niépce a contract authorizing its designation by the name Daguerre alone. Since, however, financial backing from private capital proved impossible, the process was offered to the French Government, who eventually (July, 1839) purchased it, donated it to the world at large and assigned to Daguerre and to I. Niépce annual pensions of 6000 and 4000 francs, respectively, with corresponding half benefits during the lives of their widows.

There has been much controversy as to the relative shares of J. N. Niépce and Daguerre in the invention of photography. The former was unquestionably the first to produce photographs in the camera and to fix images on asphalt. He is also without doubt the inventor of heliography, which made possible the photo-mechanical reproduction of pictures by the printing press. However, the first use of silver iodide as a light sensitive substance in the camera obscura, the discovery of the development of the scarcely visible image by mercury vapors, and the discovery of the fixation of silver images belong to Daguerre.

Subsequent to the disclosure of Daguerre's process to the French Academy of Sciences on Aug. 19, 1839, the inventor was widely acclaimed by many honors including election (1839) to the Royal Society of London. A monument of Daguerre was erected in 1890 in Washington, D. C., by the Photographers Association of America. [For photograph see Anthony's Photographic Bulletin *21*, frontispiece (Feb. 8, 1890).]

DE LA RIVE, AUGUSTE ARTHUR

Born Oct. 9, 1801, at Geneva, Switzerland; died Nov. 27, 1873, at Marseille, France, age 72.

This pioneer Swiss physicist was the son of Charles Gaspard de la Rive (1770–1834), professor (1802) of pharmaceutical chemistry and rector (1825) at the Academy of Geneva, and the father of Lucien de la Rive (1834–1924). After early studies at the College and then at the Academy he studied law for several years. His inherited love of science soon prevailed, however, and at the age of 22 he joined the faculty of the Academy of Geneva first (1823) succeeding Prevost as professor of general physics and soon thereafter (1825) on the death of M. A. Pictet inherited the chair of experimental physics. For more than fifty years he was an active contributor to the progress of physics, notably in the fields of electricity and heat.

In 1822 he became deeply interested in Ampère's studies on the relation between electricity and magnetism and performed a series of delicate and fruitful experiments which Ampère came to the de la Rive country place to witness. This work also paved the way for a long and close friendship with Michael Faraday.

With de Candolle he studied the unequal thermal conductivities of various kinds of wood, including a demonstration that the thermal flow in the direction of the fibers was greater than that perpendicular to them. With François Marcet (1803–1883) he investigated the specific heats of gases and methods for determining the temperature of the earth's crust. He made an exhaustive study of the phenomena which accompany the Aurora Borealis or Northern Lights and devised a series of beautiful lecture experiments which duplicated many of them. He studied the electrolytic conductance of solutions and early espoused the view that in solution salts were partially dissociated into oppositely charged particles which under the influence of a direct current moved toward the electrode of opposite polarity. This work led him to the discovery (1840) of a process for electroplating of brass and bronze for which he received a prize of 3000 francs from the French Academy of Sciences. He published many original memoirs on electricity, magnetism, the nature of the electric arc, the propagation of electricity through solids, solutions, and rarefied gases. His principal literary work (1854–58) was the three-volume "Traité d'Électricité Théorique et Appliquée." He edited (1836–45) the literary and scientific parts of the "Bibliothèque Universelle" which were then united, and compiled alone (1841–45) as supplementary to it, five volumes of the "Archives de l'Électricité." Conjointly with De-Marignac and others he prepared (1846–57) thirty-six volumes of the

"Archives des Sciences Physiques et Naturelles" and nine volumes (1858–60) of the "Nouvelle Periode" of the same review.

De la Rive became (1840) a correspondent and later (1864) a foreign associate of the French Academy of Sciences and was elected (1846) as a foreign member of the Royal Society of London. With the Prix Monthyon received for his invention of electrogilding he founded a quinquennial prize to be awarded for the discovery most useful to Genevese industry and later augmented this sum by a legacy.

B Proc. Roy. Soc. (London) *24*, xxxvii-xl (1871): B Nature *9*, 143–144 (1873).

EYKMAN, JOHAN FREDERICK

Born Jan. 19, 1851, at Nijkerk, Holland; died July 1, 1915, at Groningen, Holland, age 64.

This Dutch organic and pharmaceutical chemist is not to be confused with his compatriot Christiaan Eijkman (1858–1930), winner of the 1929 Nobel Prize in physiology and medicine.

Up to the age of 17, Johan Frederick Eykman was privately educated by his father. The boy then associated himself with a pharmacist at Zaandam, also studied the subject independently, and at the age of 23 obtained (1874) his pharmaceutical diploma. Meantime, he had studied at the University of Amsterdam where for several years (1871–76) he also served as assistant to Professor J. W. Gunning (1827–1901) and gave instruction in analytical chemistry and toxicology. With the intention of undertaking further study toward a doctorate in physical science, Eykman entered (1875) the University of Leyden, but had scarcely begun his work when he was invited by the Japanese government to become Director of the Institute of Pharmacy and Hygiene at Nagasaki, Japan. The first period (1877–1885) of his professional life was spent in the Orient. Upon his return to Holland, he was first (1886–88) associated with J. H. Van t'Hoff (1852–1911) in the latter's laboratory and subsequently with the Health Service of Amsterdam. After declining (1890) a call to succeed Van der Burg in the chair of pharmacy and toxicology at Leyden, Eykman later (1897) accepted a professorship at the University of Groningen. Here, after the withdrawal (1905) of Professor A. F. Holleman (1859–) to Amsterdam and the subsequent division of his post into inorganic and organic sections, Eykman became professor of organic chemistry for the last nine years (1906–15) of his life.

Professor Eykman's long stay in Japan was devoted to various aspects of the development of pharmacology. Initially (1877) at

Nagasaki (a place now forever famous from its experiences in 1945 with the second atomic bomb) he directed a laboratory charged with the control of domestic and imported pharmaceuticals and mineral waters. For three years (1878–81) he carried on similar work in Tokyo where for four years (1881–85) he held a professorship at the University, lecturing in German with the assistance of a Japanese interpreter. During his Japanese stay, he took a principal part in the reformation of the Japanese Pharmacopeia, an undertaking which proved so formidable that he completed it only after his return to Europe. Because of poor health Eykman resigned his Japanese appointments in 1885, spent a brief period of study at the celebrated botanical garden in Buitenzorg, Java, and the next year returned to his native Holland.

Professor Eykman's researches contributed not only to pharmacology but also to organic and to physical chemistry. He was a pioneer in the development of practical cyroscopy and simplified the elegant freezing point methods of Raoult (1830–1901) and of Beckmann (1853–1923) through the invention of the Eykman "depressimeter" [Z. physik Chem. *2*, 964–966 (1888)]. He made very extensive studies of the optical refractivity of organic compounds, showed that the original Lorentz-Lorenz constant for specific refraction failed to hold rigorously over wide temperature ranges, and extended the work of Gladstone (1827–1902) and of Brühl (1850–1911) on the calculation of molecular refraction of organic compounds as a constitutive function derivable from the individual contributions of component structural groups. Eykman was the first [Chem. Weekblad *1*, 453–461 (1904); *2*, 59–72, 79–93 (1905)] to effect the catalytic rearrangement of phenol ethers to hydroxyketones; his method employing zinc chloride has, however, subsequently been largely improved by the substitution of aluminum chloride in the important synthetic procedure now usually designated as the Fries rearrangement.

P_1B Rec. trav. chim. *35*, 365–420 (1916) (incl. bibliog.). B J. chim. phys. *13*, 507–508 (1915).

FRASCH, HERMAN

Born Dec. 25, 1851, in Gaildorf, Würtemberg, Germany; died May 1, 1914, in Paris, France, age 63.

This notable chemical engineer, chemist and inventor came to America in 1868 at the age of 17, secured a position in the laboratory of Professor John M. Maisch of the Philadelphia College of Pharmacy, trained himself in chemistry through private study and for a few years

maintained a consulting laboratory in Philadelphia. In 1876 he patented a process for the refining of paraffin wax whose sale to the Cleveland Petroleum Company resulted in his removal to Cleveland, where for eight years (1877–85) he served as chief chemist of the Standard Oil Company at a salary reputed to be the highest paid at that time to any man of his profession. In 1885 he removed to London, Ontario, Canada, organized the Empire Oil Company, and brought to completion his important method for the desulfuration of petroleum by heating with copper oxide. This development, by making available many Canadian, Ohio, Indiana, and Illinois petroleums which heretofore had been virtually unusable, represented one of Frasch's most important contributions. He himself records that his sale of certain patents together with the Empire Oil Company was paid for in Standard Oil Company stock selling at the time at 168 and paying 7%; after his desulfurizing process had been perfected and thoroughly established he was able to sell at 820 half of his Standard Oil holdings which for some time had been paying 40%.

Although in addition to his development of the refining of petroleum Mr. Frasch had also invented and patented numerous other chemical methods, his name is most frequently associated with his revolutionary method for the mining of sulfur. The occurrence of large deposits of free sulfur in Louisiana had been known since 1865, but because they were covered by thick layers of quicksand application of conventional mining methods had proven impossible. Frasch devised (1891) an entirely new approach involving melting of the sulfur by superheated steam forced into the deposit, the molten element being brought to the surface through a smaller pipe surrounded by the steam supply. So much fuel was required for the generation of the necessary steam, however, that the process proved prohibitively expensive until 1901 when the discovery of nearby oil fields provided abundant cheap fuel. The story of the place of the Frasch process in the development of the American sulfur industry has been most interestingly portrayed by Williams Haynes in his book entitled "The Stone That Burns" (D. Van Nostrand Co., Inc., New York City, 1942). [Models demonstrating the Frasch process have been described by several authors; e.g., J. Chem. Education *7*, 1385–1387 (1930); *8*, 1630–1633 (1931).]

In 1912 Mr. Frasch received the sixth award of the Perkin Medal; his speech of acceptance of this honor is extensively recorded in the three 1912 papers cited below and a digest of them, amplified by numerous photographs, is available elsewhere [J. Chem. Education *6*, 129–138 (1929)].

In 1928 there was established by testamentary trust of his wife the

Herman Frasch Foundation for Chemical Research with funds of some $800,000. The foundation is administered by the United States Trust Company of New York under the guidance of the American Chemical Society for the promotion of research in agricultural chemistry.

P_3B J. Ind. Eng. Chem. *4*, 131–140 (1912); *6*, 505–506 (1914); B Metall. Chem. Eng. *10*, 73–82 (1912): B J. Soc. Chem. Ind. *31*, 168–176 (1912); *33*, 539 (1914): B J. Chem. Education *5*, 129–138 (1929); *12*, 20–21 (1935): P_3B Chem. Ztg. *38*, 721–723 (1914): B Dict. Am. Biog. *6*, 602–603 (1931): P_1B Natl. Cycl. Am. Biog. *19*, 347–348 (1926).

GABRIEL, SIEGMUND

Born Nov. 7, 1851, in Berlin, Germany; died March 22, 1924, in Berlin, Germany, age 73.

Like his contemporary Wilhelm Koenigs (1851–1906), this German organic chemist spent largely in one place a long quiet life devoted to laying the foundations of the structural and synthetic aspects of his field.

His early education in his native Berlin had placed heavy emphasis on classical studies particularly with reference to Latin and Greek. Towards its conclusion, however, through his perusal of Regnault-Strecker's *Lehrbuch der Chemie* and similar volumes, he began to lean toward science and commenced his study of chemistry by attending the Berlin lectures of the famous A. W. Hofmann (1818–1892) on organic chemistry and of Schneider (1825–1900) in the inorganic field. For a two-year period (1872–4) he engaged in advanced study at the University of Heidelberg. Here he obtained his doctorate (1874) under Bunsen (1811–1899) but as sometimes happened at that time was not required to submit any dissertation. He promptly became connected with the University of Berlin with which for 46 years (1875–1921) until his retirement he was continuously associated in various capacities including that of privat-docent, assistant to Emil Fischer (1852–1919), and professor of organic chemistry.

Although no complete bibliography of Gabriel's publications appears to have been published, his colossal contributions to the development of organic chemistry spread over a vast territory from which only a few examples may be cited here. A long series of studies on the condensation of phthalic (and other) anhydrides involved his demonstration [Ber. *17*, 2521–2527 (1884)] of the structure of phthalylacetic acid and led to the first synthesis [Ber. *19*, 1653–1656; 2354–2363 (1886)] of isoquinoline, a base discovered in coal tar only the

previous year [Rec. trav. chim. *4*, 125–129 (1885)] by Hoogewerf and van Dorp. Another important field extensively investigated by Gabriel was that of basic heterocyclic compounds, notably the diazines. He was the first [Ber. *26*, 2210–2216 (1893)] to prepare phthalazine (4,5-benzopyridazine or 2,3-benzodiazine). With his student Colman he was the first [Ber. *32*, 1525–1538 (1899)] to prepare pyrimidine (1,3-diazine) and later himself devised [Ber. *33*, 3666–3668 (1900)] a simple method for its preparation from barbituric acid (malonylurea) by conversion to 2,4,6-trichloropyrimidine and subsequent reduction of the latter with aqueous zinc dust suspension. The long-sought parent quinazoline (1,3-benzodiazine) was also first obtained [Ber. *36*, 800–813 (1903)] by Gabriel. To most present-day students of organic chemistry, however, his name is probably most familiar through the extremely important general synthetic method for the preparation of primary amines which involves the condensation of potassium (or other alkali) phthalimide with a suitable halogen compound followed by subsequent hydrolytic cleavage of the N-substituted phthalimide derivative. Gabriel's first paper on this sequence [Ber. *20*, 2224–2236 (1887)] was followed by many others developing and amplifying the method which is still universally designated as the Gabriel synthesis.

P$_1$B Ber. *59-A*, 7–26 (1926).

HEMPEL, WALTHER MATHIAS

Born May 5, 1851, at Pulsnitz, Saxony, Germany; died Dec. 1, 1916, at Dresden, Germany, age 65.

This German chemist, whose name will forever be associated with the development of gas analysis, received his early education at the Polytechnic Academy of Dresden to which city his family had removed soon after his birth. After serving (1870) at the siege of Paris during the Franco-Prussian War, Hempel entered (1871) the University of Berlin, where he attended the lectures of A. W. Hofmann (1818–1892) and of A. von Baeyer (1835–1917). Despite its charm for most young chemists of the period, Hempel recoiled from organic chemistry and soon transferred to the University of Heidelberg where, under the influence of Bunsen (1811–1899), he developed particular interest and aptitude in chemical analysis and obtained (1872) his doctorate. Hempel's entire subsequent career was spent in Dresden. For three years (1873–6) he was an assistant in the Central Public Health Office and for two more (1876–8) was similarly associated with R. Schmitt (1830–1898) in the chemical laboratory of the Dresden Polytechnic, afterward to be known as the Dresden Technische

Hochschule. Upon the withdrawal of H. W. Stern (1811–1889) the twenty-nine year old Hempel succeeded (1878–92) to the chair of technical chemistry. When R. Schmitt in turn became emeritus, Hempel married a Boston, Massachusetts, girl whom he had met in Dresden and became (1893–1912) professor of inorganic and technical chemistry until ill health compelled his own retirement. Thus, in various capacities Hempel was associated with this single Dresden institution for 36 years.

Hempel's contributions to science and technology were primarily concerned with the analysis of gases. He introduced the principle of measurement of gas volume in one apparatus and absorption of a particular gas in another, a procedure which although now regarded as routine represented a great advance over the techniques of Winkler (1838–1904). Furthermore, although Bunsen had almost exclusively employed mercury as the confining liquid, Hempel developed the employment of water and the use of aqueous or liquid absorbents. He very early (1877) devised the gas burette and various gas pipettes still known by his name. The so-called Hempel distilling head, however, seems to have been reported [Chem. Ztg. *10*, 371 (1886)] by one Rudolf Rempel and its current association with Hempel's name is obscure. Hempel improved and simplified the determination of heats of combustion of fuels by development of a calorimetric bomb and corresponding accessories. He is said to have been the first (1889) to recognize that electrolysis of aqueous salt solutions could serve as a practical source of both chlorine and alkali; in this work he employed an asbestos diaphragm and by introduction of carbon dioxide into the cathode compartment obtained the alkali in the form of its carbonate.

Hempel prepared (1880) a book entitled "Neue Methoden zur Analyse der Gase" which came to a second edition (1890) as "Gasanalytische Methoden," a title retained in the subsequent 3rd (1900) and 4th (1913) editions. English translations of the 2nd and 3rd German editions were prepared by L. M. Dennis (1863–1936) of Cornell University.

Hempel made many visits to England and six times spent long vacations in the United States. He received (1897) an honorary degree from the University of Leipzig, the Doktor Ingenieur degree (1912) from the Karlsruhe Technische Hochschule and in the latter year served as vice-president of the German Chemical Society.

P_1B Ber. *53-A*, 123–143 (1920): P_3B Chem. Ztg. *41*, 85–87 (1917): B Z. angew. Chem. (Aufsatzteil), 1–5 (1917): B Ber. Königl. Sächs. Ges. d. Wissenschaften, Leipzig, Math.-phys. Klasse *69*, 580–588 (1917) (incl. bibliog.).

HEPP, EDWARD

Born June 11, 1851, at Strassburg, Germany; died June 18, 1917, age 66.

This German organic dyestuff chemist came from an Alsatian Protestant family. After completion (1869) of his early education at the Strassburg Gymnasium and Academy, he expected to enter l'École Polytechnique in Paris, but the death of his father during the war of 1870 necessitated a change of plan. Following a year of study with Bunsen at Heidelberg, Hepp became (1872) an assistant to A. von Baeyer at the newly established university of his native Strassburg and accompanied him in the same capacity upon the master's call (1875) to succeed Liebig at Munich. Although Hepp apparently entertained the idea of becoming a university teacher, he was so nervously upset at appearing before an audience that he turned instead to industrial research, to which he devoted the remaining 39 years (1878–1917) of his professional career. He began this interest with a year (1878) at the Badische Anilin und Soda Fabrik, then shifted for a five-year period (1879–84) to the dyestuff firm of Oehler at Offenbach a.M., transferred for a decade (1885–95) to Kalle-Biebrich, where he directed a laboratory, and completed his industrial career with 22 years in a similar capacity at Meister, Lucius and Brüning Höchst Farbwerken.

His dissertation comprised a study of the condensation of benzenoid hydrocarbons with chloroacetaldehyde and a study [Ber. *6*, 1439–1440 (1873); *7*, 1409–1419 (1874)] of the conversion of the products to substituted ethylenes. His first (1882) important discovery in the dyestuff field was that of Metanil yellow (English Colour Index No. 138), a yellow azo dye derived from coupling of diazotized metanilic acid with diphenylamine. With his frequent collaborator, O. Hess, he subsequently [Ber. *19*, 2251–2259 (1886)] investigated the azo dyes derived from pyrrole and although these proved without technical importance, the study laid the foundation for subsequent advances with the pyrazolone colors. With Hess, Hepp subsequently published in the *Berichte* and *Annalen* more than forty papers dealing with the chemistry of complex dyestuffs such as the safranines, indulines, rosindulines, fluorindines, and individually important colors such as Magdala Red (E.C.I. No. 857) and especially azophenin (E.C.I. No. 860). His last important paper [Ber. *46*, 709–712 (1913)] demonstrated the structure of Anthraflavon G. (E.C.I. No. 1095).

His name is still brought to the attention of students of elementary organic chemistry through his work with Otto Fischer (1852–1932) [Ber. *19*, 2991–2995 (1886); *20*, 1247–1253 (1887)] on the conversion

of N-nitroso derivatives of secondary aromatic amines to the corresponding isomeric p-nitroso secondary amines, a general reaction still universally designated as the Fischer-Hepp rearrangement.

B Ber. *51*, 165–168 (1918): B Z. angew. Chem. *30*, (Wirtschaftlicher Theil) 384 (1917).

JACOBI, KARL GUSTAV JACOB

Born Dec. 10, 1804, at Potsdam, near Berlin, Germany; died Feb. 18, 1851, at Berlin, Germany, age 47.

This distinguished German mathematician, the son of a Berlin banker of Jewish descent, was a younger brother of Moritz Hermann Jacobi (1801–1874), discoverer of electrotyping. At the age of 17 he entered the University of Berlin where he obtained (1825) his doctorate with a thesis on the theory of fractions. Most of his active professional career was spent at the University of Königsberg, where during eighteen years he served successively as privat-docent (1826–7), assistant professor (1827–32) and associate professor (1832–51) of mathematics. During the last seven years (1844–51) of his life he was located at Berlin as a member of the Berlin Academy on pension from the Prussian Government.

K. G. J. Jacobi's professional contributions lay entirely in the mathematical field and were concerned primarily with such aspects as elliptic functions ["Fundamenta nova theoriae Functionum ellipticarum" (1829)], theory of numbers ["Canon arithmeticus" (1839)], differential equations, calculus of variations, infinite series, and determinants ["De Formatione et proprietatibus determinantium" (1841)]. Although the idea of determinants antecedes Jacobi and the name was assigned (1812) by A. L. Cauchy (1789–1857), Jacobi made their theory the common property of mathematicians and invented the functional determinant which by his British contemporary J. J. Sylvester (1814–1897) has been designated as the Jacobian. A seven-volume edition of Jacobi's complete works was published (1881–91) by the Berlin Academy.

Since biographical references in the periodical literature are sparse, two special sources may be mentioned. The large number of letters comprising his correspondence with his brother M. H. Jacobi in St. Petersburg (now Leningrad) have been published in book form [Ahrens' "Briefwechsel Zwischen K. G. J. and M. H. Jacobi" (1907)]. Furthermore, an extensive biography containing K. C. J. Jacobi's portrait as its frontispiece was prepared by Leo Koenigsberger and published (1904) as a memorial on the 100th anniversary of his birth.

JACOBI, MORITZ HERMANN VON

Born Sept. 21, 1801, at Potsdam (near Berlin), Germany; died March 10, 1874, at St. Petersburg (now Leningrad), Russia, age 73.

This German-born scientist and engineer, who is not to be confused with his younger brother, the illustrious mathematician Karl Gustav Jacob Jacobi (1804–1851), spent the latter half of his life in Russia.

Pursuant to the wish of his parents he first studied architecture at Göttingen, subsequently entering government construction work in his native city. Soon (1833) M. H. Jacobi removed to Königsberg, East Prussia, where his brother was then teaching mathematics at the University, and where he himself began to turn from architecture to pure and applied physics and chemistry. He next accepted (1835) an appointment at the University in Dorpat, then and now a part of Russia, but for a few years after the First World War belonging to Estonia. While his researches here were still in progress he followed a call (1837) to St. Petersburg where Emperor Nicholas I was developing a scientific center by attracting scientists from all Europe. Here he became a member of the Imperial Academy of Sciences and devoted the remainder of his life to research and study.

Most of M. H. Jacobi's significant accomplishments relate to the generation or use of electricity. While still at Königsberg he published (1835) a pamphlet entitled "Memoire sur l'Application de l'Électromagnétisme au Mouvement des Machines" in which he described the first direct rotatory action electromagnetic motor. At Dorpat he devised an electric wet battery very similar to that independently discovered (1836) by John Frederic Daniell (1790–1845). Since Emperor Nicholas was particularly interested in the application of Jacobi's motor to the propulsion of boats, the generation of sufficient power was imperative. In pursuit of its development Jacobi built a 28-foot boat powered by a wet battery comprising 64 cells with platinum and zinc electrodes, the noble metal having a total surface of 11 square feet. M. H. Jacobi also pioneered in telegraphy and laid (1843) from St. Petersburg to suburban Zarskoje Selo (now Dietskoye Selo) the first underground telegraph line. This work on the transmission of electricity led him to studies on conductivity and electric resistance, in the course of which he devised methods and apparatus for its measurement amazingly similar to those of Wheatstone (1802–1875) in England, although there can be no doubt of their independent efforts.

The major contribution of M. H. Jacobi to science and technology, however, was his discovery (1838) of galvanoplasty, i.e., the repro-

duction of the forms of objects by electrodeposition of metal, now commonly known as electrotyping. He announced this discovery on Oct. 5, 1838, in a letter to the permanent secretary of the Imperial Academy of St. Petersburg (where he by that time had located) and subsequently (1840) published a 63-page pamphlet entitled "Die Galvanoplastik." His priority has been disputed by C. J. Jordan of London and by T. Spencer of Liverpool but Jacobi's claims are strongly supported by a letter published [Ann. chim. (4) *11*, 238–248 (1867)] thirty years later by Becquerel and by the investigations of H. Heinrich [J. Chem. Education *15*, 565–575 (1938)].

It was M. H. Jacobi's misfortune to live during a period of extremely rapid development in the field of galvanic electricity so that many of his discoveries were independently and simultaneously made by others whose residence in countries where the dissemination of knowledge was easier led to their immediate recognition.

Mention should be made of a volume published (1907) by W. Ahrens comprising a record of correspondence ("Briefwechsel") between M. H. Jacobi and his brother K. G. J. Jacobi.

2 P_3B J. Chem. Education *15*, 565–575 (1938).

KOENIGS, WILHELM

Born April 22, 1851, at Dülken, Prussian Rhineland, Germany; died Dec. 15, 1906, at Munich, Germany, age 55.

This German organic chemist spent the thirty years comprising his active professional career immersed in organic research at the Baeyer Academy and the University of Munich.

His early education up to the age of 17 was received at Cologne; it was followed by a period of brief studies in other German centers of learning. These included Berlin and Wiesbaden, where at the former he was influenced by A. von Baeyer (1835–1917), A. W. Hofmann (1818–1892), and R. H. Finkener (1834–1902) and at the latter by C. R. Fresenius (1818–1897). These experiences having determined Koenigs to pursue advanced studies in organic chemistry, he next spent three years (1871–74) in the laboratory of Kekulé at Bonn, where he attained his doctorate in 1875. During this period he also studied at Bonn under G. vom Rath (1830–1888) in mineralogy and under Clausius (1822–1888) in physics and attended at Heidelberg the lectures of Bunsen (1811–1899) and Kirchhoff (1824–1887). After concluding his professional preparation with a single postdoctoral semester at the Polytechnic of Zurich, Switzerland, Koenigs joined the already distinguished staff of Baeyer's laboratory in Munich. Here

for the remaining 30 years (1876–1906) Koenigs (who never married) quietly devoted himself to organic research, declining (1897) a call to succeed Ludwig Claisen (1851–1930) at the Technische Hochschule of Aachen.

Koenigs' scientific contributions, coming at a time immediately following the formulation of the structural theory of organic chemistry, covered a wide range of topics. They included syntheses of many aliphatic, aromatic and heterocyclic compounds, studies of the behavior of pyridine and quinoline derivatives toward alkali fusion, investigations in the camphor series, and especially important advances in the understanding of the structures of cinchona alkaloids. One of the last of Koenigs' 92 published papers comprises a valuable summary [Ann. *347*, 143–232 (1906)] of the then existing knowledge of the structure of quinine, a substance whose total synthesis Koenigs had hoped to achieve but which was not actually effected until many years later in other hands [R. B. Woodward and W. E. Doering, J. Am. Chem. Soc. *66*, 849 (1944); *67*, 860–874 (1945)]. It is of interest, however, that Koenigs was first to prepare synthetic quinoline, anticipating by its preparation from N-allylaniline [Ber. *12*, 453 (1879)] and from a mixture of acrolein with aniline [Ber. *13*, 911–913 (1880)] even the important synthesis devised by his life-long friend Skraup (1850–1910).

P_1B Ber. *45*, 3781–3830 (1912) (incl. bibliog.); B Ber. *40*, 1 (1907).

Lodge, (Sir) Oliver Joseph

Born June 12, 1851, at Penkhull, near Stoke-on-Trent, Staffordshire, England; died August 22, 1940, at Normanton House, Lake, near Salisbury, Wiltshire, England, age 89.

This great physicist, educator, philosopher, and author, eldest of eight sons, was the brother of (Sir) Richard Lodge (1855–1936), distinguished historian and professor of history at the University of Edinburgh, of Alfred Lodge (1854–1937), mathematician, and of Eleanor Constance Lodge (1869–1936), historian and principal of Westfield College, London.

Owing to the father's desire that his eldest son should succeed him in his pottery supply business, Oliver's elementary education was terminated at the age of 14. For much of the subsequent eight years (1865–73) young Lodge devoted himself primarily to office routine, solaced by the acceptance of periodical invitations from a maternal aunt for visits in London. During some of these holidays he attended classes in chemistry at the College of Chemistry in Great Marlborough Street, geology lectures at King's College, and above all lectures on

heat by John Tyndall (1820–1893) at the Museum of Geology in Jermyn Street. Thus inspired he undertook private study, home experimentation with primitive apparatus, and attended chemistry classes at Wedgwood Institute in nearby Burslem. As a consequence of attaining First Class in eight different subjects he was selected to attend a winter course for science teachers at the Royal College of Science, South Kensington, London. His father reluctantly consenting, young Lodge here attended the lectures of (Sir) Edward Frankland (1825–1899) in chemistry, Frederick Guthrie (1833–1886) in physics, and Thomas H. Huxley (1825–1895) in biology, meanwhile taking additional work at King's College in mathematics, mechanics, and physics. This program was followed by a period at University College where he read mathematics under O. Henrici (1840–1918) and W. K. Clifford (1845–1879). While still primarily engaged on his father's business, Lodge passed the London matriculation examination; subsequently he passed (1875) the final examination for B.Sc. and two years later (1877) that in electricity for his D.Sc.

Lodge began his professional career by a period at University College, London, first as demonstrator in physics under (George) Carey Foster (1835–1919), then as assistant professor. At the age of 30 Lodge was appointed (1881) to the chair of physics at the newly established University College in Liverpool where during the next 19 years (1881–1900) he initiated and executed the researches which firmly established his reputation as a physicist. In 1900 he accepted an invitation to become the first Principal of the newly chartered University of Birmingham, where for nearly two decades (1900–19) until his retirement at age 68, he concerned himself with the formulation and development of broad university policy, leaving details of its administration to the Vice-Principal. Upon retirement he withdrew to his home near Salisbury where for another two decades he actively pursued his life as author and philosopher.

Of Lodge's many contributions to physical science, his work on electromagnetic radiation and his heroic experiments on the relative motion of the luminiferous ether and matter are the most conspicuous. In his extensive studies of the propagation of electric waves along wires he nearly anticipated the work of H. R. Hertz (1857–1894) on the realization of Clerk Maxwell's (1831–1879) prophecy of electromagnetic waves in space. His contributions to the development of wireless telegraphy were numerous and important. An experiment [Nature *41*, 368 (1889–90)] still known by his name first showed that the dialling of a radio receiver is essentially a matter of adjusting the capacitance of the circuit to electrical resonance with the desired transmitter. In a Royal Institution discourse of June 1, 1884 [Proc.

Roy. Inst. *14*, 321–349 (1893–5)] he showed experiments which foreshadowed the ultra short wave advances which have only recently been realized. He devised and named as a "coherer" the tube loosely filled with metal filings which was an essential component of primitive radio receivers. In a British patent (11,575 of 1897) he pointed out the necessity for syntony (tuning) between transmitter and receiver; this later became a matter of such importance that the patent was acquired by the Marconi Company, while its American counterpart was the subject of large commercial transactions in the United States after Lodge had assigned it to a London financier for the sum of one dollar. Much earlier (1884) Lodge had shown that dust or smoke could be dispersed by electrostatic discharge in work which formed the basis for the later development by F. G. Cottrell (1877–1948) and others of commercial electrostatic precipitation.

Even this brief digest of Sir Oliver's life would be incomplete without some allusion to his concern with psychical philosophy and research. Indeed in the public mind his attitude on the relations between religion and science, and his views on psychical research and spiritualism have somewhat overshadowed his accomplishments as a physicist and educational reformer. Beginning at the age of 33 when he joined (1884) the Society of Psychical Research, his interest in this area was equally divided between physical and mental types of allegedly supernormal phenomena. His attention was not mere scientific curiosity but based on a firm belief in the survival after death of the body of some part of the human personality. One of Lodge's most notable publications in this field is the book, "Raymond: or Life and Death" (1916) which appeared after his youngest son had been killed during the First World War.

Lodge was a prodigious worker and writer. Full references to his 1,156 works published from 1875 to 1935 have been compiled by Theodore Besterman [A Bibliography of Sir Oliver Lodge, Oxford University Press, 1935]. Including papers and books as a single group, nearly 600 components of this great record concern electricity, radio, the ether, and other physical topics, about 170 deal with philosophy and religion, 145 are on psychical research and spiritual survival, 118 are biographical prefaces and reviews, while about 70 may be designated as miscellaneous. For 28 years (1912–1940) he served as a member of the editorial board of the *Philosophical Magazine*.

Lodge married during the year (1877) in which he obtained his doctorate. During the subsequent years his life was enriched by twelve children (six sons and six daughters). Sir Oliver and Lady Lodge celebrated their golden wedding anniversary in 1927, but two years later (1929) Lady Lodge died and Sir Oliver himself died on the

63rd anniversary of his marriage. An autobiography entitled "Past Years" and published in 1932 by Charles Scribner's Sons of NewYork supplies authoritative details of his life.

Such an unusual career inevitably merited and received many honors. Lodge was elected (1887) at the age of 36 to the Royal Society of London of whose prized Rumford Medal he was later (1898) the recipient. He was President (1899–1900) of the Physical Society of London and was knighted (1902) by the British Crown. He served (1913–1914) as President of the British Association at whose meetings he was a faithful attendant for 63 years, beginning with that at Leeds (1873) and ending at Blackpool (1936) and whose evolution he traced (1931) in a book entitled "Advancing Science: Being Personal Reminiscences of the British Association in the 19th Century." He was at two intervals (1901–1904, 1932) President of the Society for Psychical Research, received (1919) the Albert Medal of the Royal Society of Arts and (1932) the Faraday Medal of the Institution of Electrical Engineers, and held honorary degrees from 13 universities.

P_1B Obit. Notices Fellows Roy. Soc. (London) *3*, 551–574 (1941): P_1B Proc. Phys. Soc. London *53*, 54–65 (1941): B Nature *146*, 327–328 (1940): B Science *93*, 296–297 (1941): P_3B Engineering *150*, 172–174 (1940): B J. Inst. Elec. Engineers *87*, 706–708 (1940): B Elec. Rev. (London) *127*, 169 (1940): P_3B Engineer *170*, 139–140 (1940): B Electrician *125*, 108, 116 (1940): B Dict. Natl. Biog. *1931–1940*, 541–543 (1949).

McMurtrie, William

Born March 10, 1851, at Belvidere, Warren County, New Jersey; died May 24, 1913, in New York City, age 62.

This American chemist and chemical technologist left his imprint upon chemical society in various ways which still have bearing upon professional activities in the chemical field. After becoming attracted to chemistry at a very early age, he began (1867) his professional training at Pardee Scientific School of Lafayette College at Easton, Pennsylvania. In those days there was no special curriculum specializing in chemistry, and he graduated (1871) with a bachelor's degree in Mining Engineering. Subsequently, he pursued advanced studies at Lafayette College from which he received the degrees of S.M. (1877) and Ph.D. (1875).

Following his baccalaureate degree, McMurtrie became (1871–3) assistant to Dr. R. J. Brown, then chief chemist of the U. S. Department of Agriculture at Washington, D. C., and in 1873, at the age of 22, himself succeeded to this office which he held for the next four years, during which time he obtained his doctorate. A second period of McMurtrie's life (1878–82) was spent as a special agent of the U. S. Department of Agriculture. His first assignment (1878) was as special commissioner to the Exposition Universelle at Paris; during his stay abroad he made extensive studies of the beet sugar industry, the results of which assembled in a substantial report (U.S.D.A. Special Report No. 28, 1880) formed the basis for the start of a beet sugar industry in the United States. In the course of subsequent assignments Dr. McMurtrie made notable similar reports on Sumac (1880), Production of Wine (1882), Examination of Raw Silks (1883), Structure and Strength of Wool (1885), and the Examination of Wool (1886).

A third period comprised his work in Illinois, beginning with his appointment (1882) as Professor of Chemistry at the University of Illinois, service (from 1884) as chemist of the Illinois State Board of Agriculture, and (from 1886) of the Illinois Agricultural Experiment Station. From these positions he resigned (1888) at age 37 to become associated for the rest of his life (1888–1913) with industrial chemical development in New York. An investigation into a case of poisoning alleged to have been caused by baking powder led to a contact with officials of the Royal Baking Powder Company (now a division of Standard Brands, Inc.) with which he was associated for the subsequent 25 years, rising through the stages of consultant, chemist, manager to the rank of vice-president at the time of his death. During this period, he devised many improvements in the economical commercial manufacture of cream of tartar and tartaric acid.

After coming to New York, Dr. McMurtrie was extremely active in the reorganization (1893) of the American Chemical Society of which he served as President in 1900. [For his presidential address on "The Condition, Prospects, and Future Educational Demands of the Chemical Industries," see J. Am. Chem. Soc. *21*, 71–89 (1901).] He also was instrumental in the founding of the now famous Chemists Club of New York, particularly with respect to the establishment of its magnificent library [see Science *34*, 5–7 (1901)].

P_2B J. Ind. Eng. Chem. *5*, 616–618 (1913) (incl. bibliog.); B Science *38*, 185–187 (1913); J. Am. Chem. Soc. *48*, Golden Jubilee Number 8-A, 62 (Aug. 1926).

MILLER, WILLIAM HALLOWES

Born April 6, 1801, at Velindre, near Llandovery, Carmarthenshire, Wales; died May 20, 1880, at Cambridge, England, age 79.

This British crystallographer and mineralogist graduated (1826) from St. Johns College of the University of Cambridge with mathematical honors, six years later succeeded William Whewell at Cambridge as professor of mineralogy, and remained there as such for 48 years (1832–1870). In order to retain his fellowship, he complied with then existing university regulations by obtaining (1841) the M.D. degree, but he never entered the practice of medicine. He is not to be confused with his contemporary, William Allen Miller (1817–1870) (cf. Isis reference below).

William Hallowes Miller's greatest contribution to science was the development of a beautifully simple system of crystallographic notation which gave for crystal forms expressions readily adapted to simple mathematical calculation. The indices which he devised to define a crystal face are still universally employed and often designated as Millerian indices. The fundamentals of his method, which represented an evolutionary development based on the foundations laid by Rene Haüy (1743–1822), William Whewell (1794–1866), Carl Friedrich Naumann (1797–1873), and Franz Ernst Neumann (1798–1895), were first published (1839) in Miller's "Treatise on Crystallography" and later (1863) in more condensed, generalized and perfected form in his "Tract on Crystallography" which was essentially a second edition of its precursor. Meantime, together with H. J. Brooke, Miller published (1852) his great mineralogical work modestly entitled "Elementary Introduction to Mineralogy by the late William Phillips," a volume which contained a large quantity of data established by Miller over the years. Although these works in his principal field were his most outstanding professional contributions, he earlier prepared brief but valuable textbooks on hydrostatics (1831) and on hydrodynamics (1835).

Miller shared (1843) in the work of reconstruction of the British primary standards of length and of weight which had been destroyed (1834) by the burning of the Houses of Parliament. His account of the work on the standard of weight was published in 1856 [Phil. Trans. Roy. Soc. (London) *1856*, 753–946].

Miller was elected (1838) at the age of 37 to the Royal Society of London, later served for 16 years (1856–73) as its Foreign Secretary, and was awarded (1870) one of its two annual Royal Medals. A nickel sulfide mineral was named (1845) Millerite in his honor.

B Proc. Roy. Soc. (London) *31*, ii-vii (1880); B Proc. Am. Acad.

Arts Sci.: *16*, 461–468 (1881): B Nature *22*, 247–249 (1880): B Isis *34*, 337–339 (1943): B Dict. Nat. Biog. *37*, 430–431 (1894).

NOELTING, (DOMINGO) EMILIO

Born June 8, 1851, at Puerto del Plata, Dominican Republic, on the island of Haiti, West Indies; died August 6, 1922, at Meran (in the Tyrol), Italy, age 71.

Although this organic chemist was born in the West Indies, all of his adult life was spent in Europe, mainly in Switzerland, France, and Alsace-Lorraine. Noelting's father came from a family of Danish origin living in Hamburg, Germany, but was led by business interest to remove to the West Indies, where he married a Spanish wife and became a citizen of the Dominican Republic, which had been established in 1844. While the son was still only two years of age the family undertook to return to Europe in an unfortunate voyage during which the father died.

After a few years of elementary schooling in Hamburg a benevolent uncle made available to the 13-year-old Noelting the privilege of further study in Paris. Here for six years (1864–1870) he attended the Collège St. Barbe and the Lycée Louis-le-Grand, attaining (1870) the B.S. degree. Upon the outbreak of the Franco-Prussian War Noelting entered the Federal Polytechnic Institute of Zurich, Switzerland, where during his second year he determined to pursue chemistry as a profession. After serving as assistant to Victor Meyer (1848–1897) for one semester and to Emil Kopp (1817–1875) for eighteen months, he obtained (1875) his doctorate at the University of Zurich with a dissertation on "The Constitution of Benzene Derivatives."

For the next several years Noelting acquired practical industrial experience, first (1875–1877) as works chemist at the silk dyeing firm of Messrs. Renard, Villet, et Bunand in Lyons, France, and later (1877–1880) as research chemist with the dyestuff company of P. Monnet at La Plaine, near Geneva, Switzerland (later to become the Société Chimique des Usines du Rhône), in both of which places he was associated with his long-term collaborator F. Reverdin (1849–1931).

At this juncture, however, he accepted a call to succeed Goeppelsroeder as director of l'École de Chimie of Mulhouse, a school established by the Société industrielle de Mulhouse to train students for the Alsatian textile and dyeing industry. Here Noelting carried on and extended for 34 years (1880–1914) the distinguished work of his three predecessors, Paul Schutzenberger (1829–1897), D. A. Rosenstiehl (1839–1916), and Goeppelsroeder, assisted from 1883 by Eugene Wild, who eventually succeeded to the post upon Noelting's retirement.

Soon after the outbreak of the First World War, Noelting's frank sympathies toward the Allies forced him, at the age of 64, to flee Mulhouse for Switzerland, where he found haven first at Lausanne and later at l'École de Chimie of Geneva, where a laboratory was placed at his disposal by Ame Pictet (1857–1937). During the war his technical advice was gladly sought by various Swiss and Italian chemical companies. After the armistice, Noelting returned to Mulhouse as honorary director of the school, whose active conduct was turned over to Wild and his sub-director, Battegay.

Noelting arrived at professional maturity just at that period when the influence of the new structural theory of organic chemistry was promoting intense activity in constitutional studies of simple organic compounds. Many such were successfully carried out by Noelting, including a notable proof for the equivalence of the six hydrogen atoms of the benzene nucleus and a new demonstration [Ber. *37*, 1015–1028 (1904)] of the equivalence of its 2- and 6- positions based upon transformation of 2, 6-dinitrotoluene into derivatives whose identity he was able to establish.

Noelting also made numerous notable contributions to the chemistry of synthetic coloring matters, including the discovery of various commercially important individuals such as Phloxine (E.C.I. No. 774) (1875), Rose Bengale (E.C.I. No. 777) (1876) and Cyanosin (E.C.I. No. 776) (1876), all derivatives of fluorescein. In addition to approximately 200 journal papers, Noelting enriched the literature of organic chemistry by two important reference books. With Reverdin he published in German (1880) a volume on "The Constitution of Naphthalene and its Derivatives" which appeared (1888) as a French edition, next (1894) as the "Tabellarische Übersicht der Naphthalinderivate," and eventually (1927) as the two volumes by Van der Kam. The other, 1891 with A. Lehne, a monograph on aniline black, after passing through several French and German editions, appeared later (1904) in revised and amplified form.

Noelting was a member of the famous conference on organic nomenclature held in Geneva, April 19–22, 1892 [for a group photograph of its 36 members see J. Chem. Soc. *1938* facing page 1117]. During his early period at La Plaine he, together with Reverdin and E. Ador, founded the Chemical Society of Geneva.

P_1B Helv. Chim. Acta *6*, 110–128 (1923) (incl. bibliog.): B Ber. *55-A*, 137–140 (1923): B Bull. soc. chim. (4) *33*, 1–5 (1923): B J. Soc. Dyers Colourists *38*, 313 (1922): B Bull. soc. ind. Mulhouse *90*, 333–343 (1924): B Rev. gén. mat. color. *28*, 336–340 (1924): B Melliand Textilber. *4*, 21–22 (1923).

OERSTED, HANS CHRISTIAN

Born Aug. 14, 1777, at Rudkjöbing on the Danish island of Langeland; died March 9, 1851, at Copenhagen, Denmark, age 74.

This Danish physicist and chemist (the Latin version of whose name as Johannis Christianus Örsted accounts for the occasional use of the initials J. C.) acquired early education through his own efforts. Nevertheless, at the age of 17 he won the certificate entitling him to matriculate at the University of Copenhagen, where five years later (1799) he was awarded the degree of doctor of philosophy, with a dissertation on "The Architectonics of Natural Metaphysics." Throughout his university career he was accompanied by his younger brother, Anders Sandöe Oersted (1778–1860) who became one of Denmark's most distinguished jurists and eventual (1853) prime minister. Following completion of his university training, Hans Oersted devoted several years to lecturing, followed by almost three years of extensive European travel and study. After returning (1806) to the University of Copenhagen as professor of physics he remained as such for the rest of his life, so that his association with this single institution comprised 58 years.

Oersted's chief claim to fame rests upon his epoch-making discovery of the magnetic field accompanying an electric current, the first recognition of a connection between magnetism and electricity. This was announced on July 21, 1820, in a pamphlet of four quarto pages printed in Latin under the title, "Experimenta circa effectum conflictus electrici in acum magneticam." This was mailed to the leading scientists and scientific societies of Europe, who soon printed translations in the current periodical literature, e.g., Ann. chim. phys. (2) *14*, 417–425 (1820); Gilbert's Ann. Physik. *6*, 295–304 (1820) and many others. [As part of the centennial celebration of Oersted's discovery there was published by A. Larsen of Copenhagen a 46-page brochure entitled "La Découverte de l'Électromagnétisme" which contains facsimile reproductions of the original and many translations.] The extraordinary significance of Oersted's discovery was immediately appreciated and stimulated further experiments by other scientists. In September of the same year Ampère (1775–1836) recognized the magnetic forces existing between two wires carrying electric currents. [For discussion of the relation between Oersted's and Ampère's work see the J. Am. Inst. Elec. Engrs. *39*, 1028–1033 (1920).] The new knowledge was also immediately utilized by Johann S. C. Schweigger (1779–1857) in the invention of the galvanometer. Still further advances were soon made by the work of Faraday (1791–1867). [For a résumé of the relations of the work of Oersted and Faraday see Nature, *128*, 337–339 (1931).]

Various electrical units have by authority of the International Electrotechnical Commission been designated by the names of those significantly associated with corresponding scientific studies. Thus modern electrical units include the volt, ohm, ampere, coulomb, farad (all adopted in 1881), the joule and watt (adopted 1889), the henry (adopted 1893). To these have since been added magnetic units including the maxwell and the gauss (both adopted 1900) together with the gilbert and the oersted, both of which were approved in 1930. [For further details see *Scientific Monthly 32*, 378–380 (1931).]

Although Oersted's name is forever secure by virtue of his contributions as a physicist, he was also the first (1825) to isolate metallic aluminum. By the action of potassium amalgam upon aluminum chloride he prepared an aluminum amalgam from which distillation of the mercury in absence of air yielded a metal which looked like tin. Although Oersted himself regarded his experiments as incomplete, subsequent repetition of his method has shown that the metal can indeed be prepared in this manner. Oersted's method was subsequently modified and improved by Wöhler, who also obtained the metal in 1827, was first to describe its properties and (1845) to melt it to a coherent metallic mass.

Oersted was elected a foreign member of the Royal Society of London in 1821 and received its prized Copley Medal for 1820. A statue commemorating his electromagnetic discoveries was unveiled on Sept. 25, 1876, in Oersted Park at Copenhagen. [For picture see *Sci. Monthly 32*, 378 (1931).] An important biography by Kirstine Meyer under the title, "The Scientific Life and Work of H. C. Oersted," was published in 1920.

B Smithsonian Institution, Annual Report for 1868, pp. 166–184.

PLÜCKER, JULIUS

Born July 16, 1801, at Elberfeld, Prussian Rhine, Germany; died May 22, 1868, at Bonn, Germany, age 67.

This German mathematician and physicist, after receiving his early education in the Gymnasium at Düsseldorf, and in the universities of Bonn, Heidelberg, and Berlin, spent some years in Paris. After attaining his doctorate at Bonn, he remained there for eight years, first (1825–8) as privat-docent in mathematics, afterward (1828–33) as assistant professor. The following year (1833–4) was spent in the same capacity at the University of Berlin where he also lectured at the Friedrichs-Wilhelm Gymnasium. Following a brief interlude (1834–36) at Halle, he spent the remaining thirty-two years of his life at the

University of Bonn, first as associate professor of mathematics (1836–47) and afterward (1847–68) as professor of physics.

The mathematical contributions made by Plücker in the two decades following his sojourn in Paris assured him a secure place among the leading mathematicians of his time. His first great two-volume work "Analytisch-geometrische Entwickelungen" (1828, 1831) introduced both the abridged notation which has since characterized analytical geometry, and the analytical formulation of the principle of duality. Soon afterward (1835) his "System der analytische Geometrie" set forth the use of linear functions in place of ordinary coordinates and established so-called linear geometry. His "Theorie der algebraischen Curven" (1839) contained the six analytical relations since known as "Plücker's equations," connecting the ordinary singularities of plane curves in such a manner that any three members can be calculated in terms of the other three. This discovery has been characterized by the British mathematician Arthur Cayley (1821–1895) as the most important in modern geometry. Plücker's mathematical work was at the time, however, so coolly received in his own country that at the age of 46 he turned to physics for nearly twenty years. In 1865, however, he worked out a new geometry of space in the course of whose investigation he caused to be constructed those models now familar to students of higher mathematics. Further researches on this topic appeared (1868) in a posthumous publication, "Neue Geometrie des Raumes gegrundet auf die Betrachtung der geraden Linie als Raumselement," edited by his pupil and assistant Felix Klein (1849–1925).

During the two decades (1847–1867) in which Plücker was preoccupied with research in physics he made many important contributions in the fields of magnetism, spectroscopy, and electric discharge through gases. He discovered that the behavior of crystals in a magnetic field is influenced by their orientation and developed a theory of diamagnetism. He discovered [Pogg. Ann. Physik *107*, 77–113 (1859), *116*, 27–54 (1862)] that cathode rays are deflected by a magnetic field, but shares credit for this observation with his pupil Hittorf (1824–1914) and Sir William Crookes (1832–1919) who subsequently investigated this phenomenon in greater detail. He anticipated Bunsen (1811–1899) and Kirchhoff (1824–1887) in announcing that the lines of a spectrum were characteristic of the chemical substance which emitted them, and thus recognized the value of spectroscopy in chemical analysis. In the course of his investigations on electric discharge through rarefied gases he devised (1858) a type of tube which was constructed by Heinrich Geissler, a master glass blower and instrument maker of Bonn. Plücker himself designated these devices as Geissler tubes by which name they are still known.

They not only greatly facilitated early researches but may now be regarded as the forerunners of our modern forms of display signs and fluorescent lighting systems.

Plücker was a member of many academies and scientific societies; he was elected (1855) a Foreign Member of the Royal Society of London, whose Copley Medal was awarded him (1866) "for his researches in analytic geometry, magnetism and spectral analysis."

B Proc. Roy. Soc. (London) *17*, lxxxi–lxxxii (1868–9).

SCHULTZ, GUSTAV THEODOR AUGUST OTTO

Born Dec. 15, 1851, at Finckenstein, West Prussia, Germany; died April 21, 1928, at Munich, Germany, age 77.

This German organic industrial and dyestuff chemist, after receiving his early education in the gymnasia of Rössel, Elbing and Memel, entered (1870) the University of Königsberg, where as a student of the famous Carl Graebe (1841–1927) he obtained his doctorate (1874) with a dissertation on "Diphenyl and its Derivatives." After three years (1874–7) as Kekulé's private assistant at the University of Bonn, Schultz then became (1877–1880) a teaching assistant of R. Fittig (1835–1910) at the newly established University of Strassburg. During the Bonn period he established a life-long friendship with Richard Anschütz (1852–1937) and both collaborated with Kekulé in the second (1880) edition of the latter's "Lehrbuch der Organischen Chemie." The second period of Schultz's career (1880–95) was devoted to the industrial development of dyestuff chemistry, first as director (1880–92) of the research laboratory of the Aktiengesellschaft fur Anilinfabrikation at Berlin, later (1892–5) as works manager of the Sandoz Company at Basel, Switzerland. In the third aspect of his career Schultz returned to the academic field at the Munich Technische Hochschule, where for thirty years (1896–1926) as head of the department of chemical technology he developed an outstanding center for the training of chemists for the dyestuff industries.

Schultz's contributions to science and industry were almost exclusively in the field of coal-tar derivatives and dyestuffs. Following the studies of biphenyl comprising his doctoral dissertation, he collaborated with Anschütz in studies on phenanthrene which established the structure of this hydrocarbon. During the period of his industrial connection he was a leader in the recognition and development of the direct dyes for cotton which represented such an important stage in the growth of the dyestuff industry. Space forbids any ex-

tensive survey of his many scientific papers, since this may be obtained elsewhere [Z. angew. Chem. *35*, 172–175 (1922)]. Note is made, however, that Schultz was the first [Ber. *5*, 682–683 (1872); Ann. *174*, 201–235 (1874)] to prepare 4-bromo-, 4-chloro-, 4-nitro-, and 4-aminobiphenyl together with many other biphenyl derivatives including p-diphenylbenzene (p-terphenyl). He was first to prove (1874) that benzidine is 4,4′-diaminobiphenyl, although this important base had been discovered long before (1845) by Zinin (1812–1880). Schultz was the first [Ber. *9*, 547–549 (1876); *11*, 1754–1755 (1878); *12*, 486–490 (1879)] to prepare the isomeric 2,4′-diaminobiphenyl which he named "diphenyline." In the course of his work on phenanthrene [Ber. *11*, 215–218 (1878); *12*, 235–237 (1879): Ann. *196*, 1–32 (1878); *203*, 95–118 (1880)] there was developed [Ber. *10*, 21–24 (1877); Ann. *196*, 32–57 (1879)] the now widely used method for the preparation of phenanthraquinone by oxidation of phenanthrene with potassium dichromate and sulfuric acid, and also [Ber. *9*, 1404 (1876)] the preparation of the first mononitrophenanthraquinone, i.e., 2-nitrophenanthraquinone. In view of Schultz's subsequent development of the class of direct colors for cotton, it is of interest that he reported [Ann. *207*, 334–336 (1881)] the first (dis)azo dyestuff from benzidine; this was biphenyl-4,4′-*bis*(azo-4-phenol) obtained by coupling of tetrazotized benzidine with phenol. Although this product had no technical importance, it was the precursor of the class and of the very important Congo Red [E.C.I. No. 370] patented in 1884 by Paul Böttiger under Schultz's direction.

In addition to his experimental researches Schultz contributed heavily to the technical literature by various books. His "Chemie des Steinkohlenteers mit besonderer Berücksichtigung der künstlichen organischen Farbstoffe" (1st ed. 1882, 2nd ed. 1886–90, 3rd ed. 1900, 4th ed. with E. Ferber 1926) represented a valuable contribution to the development of the coal-tar and dyestuff industry. He also prepared (1903) a brief textbook of industrial chemistry, and a fourth part (1906) of K. Heumann's "Die Anilinfarben und ihre Fabrikation." Of all his works, however, none is more important or widely known than the famous Schultz "Dyestuff Tables." Under the name "Tabellarische Ubersicht der künstlichen organischen Farbstoffe" and with the collaboration of P. Julius (1862–1931) this work first appeared in 1888 and in an English translation by A. G. Green (1864–1941) in 1894, 1904 and 1908. Further editions of the German work were made during Schultz's life in 1891, 1897, 1902, 1914, and 1923. Subsequently a 7th edition revised and extended by Ludwig Lehmann was published in 1931–2 with supplementary volumes in 1934 and 1939. The type of compact systematic tabular representation of

commercial synthetic and natural coloring matters thus initiated by Schultz was the direct precursor of the later English Colour Index (E.C.I.) edited by F. M. Rowe and published (1924) together with a supplement (1928) by the (British) Society of Dyers and Colourists.

P_3B Z. angew. Chem. *34*, 613 (1921): B *35*, 172–175 (1922): B Chem. Ztg. *45*, 1197 (1921): B Ber. *61-A*, 82–83 (1928): B J. Soc. Dyers Colourists *44*, 181 (1928).

SCHUSTER, SIR ARTHUR

Born Sept. 12, 1851, at Frankfort-on-Main, Germany; died Oct. 14, 1934, at his estate ("Yelldall") at Tuyford, near Reading, Berkshire, England, age 83.

This German-born mathematical physicist came to Manchester at the age of 18, became a naturalized British citizen in 1875, and although despite chronic ill health an extensive traveller, carried on most of his life work in England. Schuster's parents were both of Jewish origin but while their children were still young were converted to the Christian religion. Although the Schuster family had long been established as cotton merchants in Frankfort, the annexation of the latter by Prussia after the Seven Weeks War led to their removal to Manchester, England.

After early education at the Frankfort Gymnasium, Arthur Schuster spent two years (1868–70) at the Academy, Geneva, Switzerland, where the lectures of Marignac in chemistry, Soret in physics, and Plantamour in astronomy stimulated his interest in physical science. Upon returning to his family in England, he entered his father's business, meantime attending Professor Henry Roscoe's evening classes in chemistry at Owens College. Within a year he found commercial pursuits so distasteful that he persuaded his father to allow him to take up science as his profession. After further training at Owens College in physics under Balfour Stewart (1828–1887) and in mathematics under Thomas Barker (1838–1907), he became especially interested in spectroscopy, and while still a student published his first paper [Proc. Roy. Soc. (London) *20*, 484–487 (1872)] on the spectrum of nitrogen. Upon Roscoe's advice, Schuster pursued advanced studies in this field with Bunsen, Kirchhoff, and Königsberger at Heidelberg where he soon obtained (1873) his doctorate. After brief postdoctoral studies at Göttingen with W. Weber and E. Riecke, and in Berlin with Von Helmholtz, he was associated (1876–81) at the newly established Cavendish Laboratory in Cambridge with Clerk Maxwell and later Lord Rayleigh. The 26 years comprising his active professional career, however, were spent at Owens College, Man-

chester, first (1881–88) as professor of applied mathematics and later (1888–1907) as successor of Balfour Stewart as Langworthy Professor of Physics. [For full account see the volume "The Physical Laboratories of the University of Manchester, Prepared in Commemoration of the 25th Anniversary of Sir Arthur Schuster's Professorship in Owens College," University Press, Manchester, 1906, which includes a portrait (P1, frontispiece) together with biography and bibliography (pp. 41–60).] Upon Schuster's retirement (1907) he was succeeded by Lord Rutherford, who with J. J. Thomson and Sir Arthur Eddington, had been among his many distinguished students. The last 27 years of his life were largely devoted to administration of national and international scientific affairs, including service as Secretary (1912–19) and Foreign Secretary (1920–24) of the Royal Society and Secretary (1919–28) of the International Research Council. [An autobiography entitled "Biographical Fragments" was published by Macmillan and Co. in 1932.]

Schuster's scientific work lay mainly in the fields of spectroscopy, the discharge of electricity through gases, terrestrial magnetism, optics, and mathematical theory of periodicity. It was spectrum analysis which interested him in solar eclipses; he led or participated in such expeditions to Siam (1875), Colorado (1878), Egypt (1882) and the West Indies (1886), and was enroute (1914) for a fifth to the Crimea at the outbreak of World War I. During the third of these excursions (1882), he obtained the first photographs of the solar corona. Schuster's pioneering work on electric discharge through gases was somewhat obscured by the later more spectacular contributions of Roentgen and J. J. Thomson. However, he was the first to recognize that the electrical conductivity of gases at low pressures is due to the formation of gaseous ions, and that cathode rays were much accelerated in the strong cathode field. He was the first to show how to obtain the ratio of charge to mass (e/m) by magnetic deflection of cathode rays, and made a first approximation of its magnitude which barely missed the discovery of the electron, an achievement soon realized by his former pupil J. J. Thomson. With F. E. Smith he developed the Schuster-Smith magnetometer, which became the standard instrument for measurement of horizontal magnetic force in absolute units. He invented (1898) a mathematical (periodogram) method for the recognition of periodicities in statistical material which has proven valuable in the studies of seismological, magnetic, meteorological and other natural phenomena. Although not himself making any direct experimental contribution to meteorology, he was for 32 years an active member of the Meteorological Council, and was directly responsible for the establishment (1905) at the University

of Manchester of the first British lectureship for the teaching of meteorological science.

Schuster was elected (1879) to the Royal Society at age 28, ultimately received its Royal Medal (1893), Rumford Medal (1926), and its highest award, the Copley Medal (1931), and was knighted (1920) by the British Crown.

P_1B Obit. Notices, Fellows Roy. Soc. (London) *1*, 409–423 (1932–5): P_1B Astrophysical J. *81*, 97–106 (1935): B Proc. Phys. Soc. London *47*, 1130–1134 (1935); *48*, 243–246 (1936): B Nature *134*, 595–597 (1934). B Dict. Natl. Biog. *1931–40*, 791–793 (1949).

THOMPSON, SILVANUS PHILLIPS

Born June 19, 1851, at York, Yorkshire, England; died June 12, 1916, in London, England, age 65.

This British physicist, electrical engineer, and teacher came from a Quaker family and was himself throughout his life an active and earnest member of the Society of Friends. His early education began at the Friends' Bootham School in York where his father was master, and continued at a Quaker training college called Flounders Institute at Pontefract, Yorkshire. Beginning at the age of 19 he next spent five years (1870–75) as junior master of Bootham School, where his father was still senior master. After a brief period of about a year during which he studied both at the Royal School of Mines at South Kensington, London, and spent a summer semester at Heidelberg, Thompson accepted an appointment at University College, Bristol, to which as lecturer in physics (1876–8), and professor of physics (1878–85) he devoted nine years. At the age of 34 Thompson was appointed Principal and professor of applied physics and engineering at the City and Guilds Technical College, Finsbury, London (R. Meldola being simultaneously called to the chair of chemistry), where he remained (1885–1916) for thirty-one years till his death.

Although Thompson made various contributions to science as the result of original investigations, he was especially gifted as a teacher, demonstrator, and author. He was in constant demand as a lecturer and gave many such series at the Royal Institution, the Royal Society of Arts and elsewhere. To him we owe many effective experimental illustrations of physical laws and phenomena. He devised the curious optical illusion which he called "Strobic Circles." He was always an indefatigable worker and prolific author. His "Elementary Lessons in Electricity and Magnetism," first published in 1881, went through more than forty editions and reprints including translations into French, German, Italian, Polish, and Japanese.

Three years later (1884) his second book, "Dynamo-Electric Machinery," also proved epoch-making. This was soon followed (1891) by "The Electromagnet and Electromagnetic Mechanisms." In 1910 Thompson prepared a small volume called "Calculus Made Easy: being a very simplest introduction to those beautiful methods of reckoning which are generally called by the terrifying names of the Differential Calculus and the Integral Calculus." This was written in such an unconventional, humorous and colloquial style that the author arranged to have his identity kept secret during his lifetime, the Macmillan Company publishing it under the pseudonym "F. R. S." The work was, however, so enthusiastically applauded as to require three reprintings during its first year with a second edition in 1914. Numerous reprintings subsequent to the author's death have carried his name on the title page.

In addition to these and other technical volumes Thompson was a heavy contributor to the literature of scientific biography, notably in his studies of William Gilbert (1540–1603), whose famous "De Magnete" Thompson translated, and his biographical volumes on Phillip Reis (1883), Michael Faraday (1898) and the two volume classic (1910) on Lord Kelvin. Thompson was himself a notable collector of books and gradually acquired a remarkable private library which has since become the property of the Institution of Electrical Engineers.

Professor Thompson was extremely active in the professional and scientific organizations of his period. He was elected (1891) to the Royal Society of London, and served as President of the Institution of Electrical Engineers (1899), the Physical Society of London (1901–2), the Optical Society (1905), the Society of Illuminating Engineering (1909) and various others.

A biography, "S. P. Thompson: His Life and Letters," prepared by Jane S. and Helen G. Thompson, was published (1920) by E. P. Dutton and Company.

P_1B Proc. Roy. Soc. (London) *94*, xvi–xix (1917–8): B J. Inst. Elec. Engrs. *55*, 548–551 (1917): B Nature *97*, 343–344 (1916): P_3B Electrician *77*, 359–360 (1916): P_3B Elec. World *67*, 1397 (1916): B Dict. Natl. Biog. *1912–21*, 528–529 (1927).

Vaughan, Victor Clarence

Born Oct. 27, 1851, at Mt. Airy, Randolph County, Missouri; died Nov. 21, 1929, at Richmond, Virginia, age 78.

This American biochemist, bacteriologist, toxicologist, epidemiolo-

gist, medical leader and administrator played an important role in the development of medical education in the United States.

At the age of 16 he entered Central College, Fayette, Missouri, but after the first year transferred to Mt. Pleasant College, Huntsville, Missouri, whose B.S. degree he attained in 1872 and where he tarried two years to teach chemistry and Latin. He then began graduate study at the University of Michigan, obtaining successively its M.S. (1874), Ph.D. (1876), and M.D. (1878). At this Ann Arbor institution he served as teaching assistant in chemistry (1875–1879), lecturer in medical chemistry (1879–1880), assistant professor (1880–1883), professor of physiology and pathological chemistry and simultaneously associate professor of therapeutics and materia medica (1883–87), professor of hygiene and physiological chemistry (1887–1909) and (in part simultaneously) Dean of the Department of Medicine and Surgery for 30 years (1891–1921) until his retirement at age 70. Thus from student to dean emeritus he was primarily associated with the University of Michigan for 46 years.

The first fifteen years (1874–89) of Vaughan's early active life was associated with Michigan's old chemical laboratory where were executed those fundamental researches on the separation and identification of inorganic and organic poisons which at once placed him among the nationally recognized authorities on toxicology and legal medicine. During this period his textbook on physiological chemistry (1st ed. 1878) introduced the science of biochemistry to American medical students. Vaughan's early work in this field was contemporaneous with that of W. O. Atwater (1844–1907) at Wesleyan University and R. H. Chittenden (1856–1943) at Yale, but Vaughan was undoubtedly the first in this country to occupy a chair of physiological chemistry at a medical school. Together with Frederick G. Novy (1864–) he spent a summer (1888) in Berlin at the laboratory of Robert Koch (1843–1910), from which the two returned to organize the first laboratory in the United States for the systematic teaching of bacteriology to medical students and physicians. Subsequently Vaughan developed the combined collegiate and medical course first formulated (1890) at Michigan and since widely adopted by American medical schools.

Dr. Vaughan's wide range of research and professional interest which resulted in some 324 publications may be suggested by his books. His "Cellular Toxins" (1902) (with F. G. Novy) was preceded by three expanding editions of a volume on ptomaines and leuco-ptomaines; his "Protein Split Products in Relation to Immunity and Disease" (1913) was written with two of his sons; it was followed by "Infection and Immunity" (1915), "Protein Poisons" (1917), and

eventually (in collaboration with H. F. Vaughan and G. T. Palmer) by the two volumes of "Epidemiology and Public Health" (1922, 1923). During his 75th year he published (1926) an autobiography under the title of "A Doctor's Memories." During the Spanish-American War Dr. Vaughan saw active service at Santiago; subsequently he, together with Walter Reed and E. O. Shakespeare, were appointed to investigate the shocking prevalence of disease which had occurred during that conflict. As the only surviving member of this commission Vaughan prepared its final two-volume "Report on the Origin and Spread of Typhoid Fever in U. S. Military Camps" (1904) which became a classic contribution to epidemiology.

Dr. Vaughan was active in professional societies and in the promotion of their publications. He served as President of the Association of American Physicians (1908–09), the American Medical Association (1914–15), and the National Tuberculosis Association (1919–20). He founded (1879) *Physician and Surgeon* and (1915) the *Journal of Laboratory and Chemical Medicine*, editing the latter for its first eight years, and was the first editor (1922) of *Hygeia* (now renamed as *Today's Health*), a popular health magazine of the American Medical Association. The degree of Doctor of Laws (LL.D.), the highest honor which can be conferred by an institution of higher learning, was four times awarded to Dr. Vaughan, who also possessed the unusual distinction of an honorary M.D. (1894) from the University of Illinois. Shortly before his death Dr. Vaughan received (1928) the Kober Medal of the Association of American Physicians.

The entire June, 1930, issue of the *Journal of Laboratory and Chemical Medicine* comprises a Vaughan Memorial entirely devoted to his life and work.

6 P_2B J. Lab. Clin. Med. *15*, 817–942 (1930) (incl. bibliog.): P_3B Am. J. Pub. Health *20*, 53–55 (1930); P_2B Sci. Monthly *30*, 278–281 (1930): P_3B Natl. Cycl. Am. Biog. *29*, 434–435 (1941): Dict. Am. Biog. *19*, 236–237 (1936).

Weyl, Theodor

Born Jan. 8, 1851, in Berlin, Germany; died June 6, 1913, at Charlottenberg, Berlin, Germany, age 62.

This German physiological chemist was trained at the University of Heidelberg, at Bois-Reymond Institute of Berlin and as a pupil of Hoppe-Seyler (1825–1895) at the University of Strassburg from which he obtained (1877) his doctorate with a dissertation on "Animal

and Vegetable Proteins." He then spent a year in physiological chemistry research under E. Baumann (1846–1896) at the University of Berlin, during which he discovered [Ber. *11*, 2175–2177 (1878)] the well-known sodium nitroprusside color reaction for creatinine and showed [Z. physiol. Chem. *3*, 312–322 (1879)] that the phenolic compound resulting from putrefactive cleavage of tyrosine is p-cresol. Weyl next spent three years (1879–82) in the Physiological Institute of the University of Erlangen as assistant to I. Rosenthal but subsequently returned to Berlin, where he established an independent research laboratory and afterward associated himself with the Hygienic Laboratory of the University of Berlin, then under the direction of Robert Koch (1843–1910). During this period Weyl became the first to recognize with certainty that one of the numerous amino acids obtainable from silk by acid hydrolysis was α-alanine.

In later life Weyl turned to the preparation or editing of various monumental compilations such as the ten-volume "Handbuch der Hygiene" (1896–1904), the "Handbuch der Arbeiterkrankheiten" (1908) and several others. His name is associated by organic chemists with a massive compilation (1909–11) of preparative and analytical methods, subsequently (1925–41) brought to a third edition of four volumes by J. Houben under the title Houben-Weyl's "Methoden der Organischen Chemie."

P_1B Ber. *47*, 2395–2404 (1914).

For the convenience of interested readers the names of the 76 persons whose biographical digests have appeared in this and the two preceding annual series are here tabulated with reference to the year of the particular article in which their anniversaries were cited.

Berliner, E.	1951	Del Rio, A. M.	1949
Bernouilli, D.	1950	Descartes, R.	1950
Billeter, O.	1951	Döbereiner, J. W.	1949
Black, J.	1949	Doebner, O. G.	1950
Braun, K. F.	1950	Dumas, J. B. A.	1950
Brøgger, W. C.	1951	Eykman, J. F.	1951
Brühl, J. W.	1950	Fleming, Sir J. A.	1949
Claisen, L.	1951	Frasch, H.	1951
Clapeyron, B. P. E.	1949	Gabriel, S.	1951
Dana, E. S.	1949	Gay-Lussac, J. L.	1950
Daguerre, L. J. M.	1951	Goldschmiedt, G.	1950
De La Rive, A. A.	1951	Goldstein, E.	1950

Goodyear, C.	1950	Miller, W. H.	1951
Haller, A.	1949	Munroe, C. E.	1949
Heaviside, O.	1950	Napier, J.	1950
Hell, C. M. von	1949	Noelting, D. E.	1951
Hempel, W. M.	1951	Oersted, H. C.	1951
Henniger, A. R. M.	1950	Osler, Sir W.	1949
Hepp, E.	1951	Pavlov, I. P.	1949
Herreshoff, J. B. F.	1950	Pechmann, H. von	1950
Hess, G. H.	1950	Plücker, J.	1951
Hill, H. B.	1949	Reich, F.	1949
Hofmeister, F.	1950	Reverdin, F.	1949
Hummel, J. J.	1950	Richet, C. R.	1950
Jacobi, K. G. J.	1951	Rutherford, D.	1949
Jacobi, M. H.	1951	Saussure, H. B. de	1949
Jenner, E.	1949	Schönbein, C. F.	1949
Jones, W.	1949	Schultz, G.	1951
Kjeldahl, J. G. C. T.	1949	Schuster, Sir A.	1951
Klein, C. F.	1949	Skraup, Z. H.	1950
Koenigs, W.	1951	Talbot, W. H. F.	1950
Laplace, P. S.	1949	Thompson, S. P.	1951
Lassaigne, J. L.	1950	Vaughan, V. C.	1951
LeChatelier, H. L.	1950	Wagner, G.	1949
Lodge, Sir O. J.	1951	Welch, W. H.	1950
Maberry, C. F.	1950	Weston, E.	1950
McMurtrie, W.	1951	Weyl, T.	1951
Meldola, R.	1949	Wöhler, F.	1950